AMERICAN JOURNAL OF PHYSICAL ANTHROPOLOGY 106:189–205 (1998)

Evolution of the Dentition in Prehistoric Ohio Valley Native Americans: II. Morphology of the Deciduous Dentition

PAUL W. SCIULLI*
Department of Anthropology, Ohio State University, Columbus, Ohio 43210

KEY WORDS deciduous teeth; morphology; Ohio Valley region

ABSTRACT In order to evaluate the microevolutionary dynamics of morphological features of the deciduous dentition, I collected data on the variation of 57 features (33 crown and 24 root) from prehistoric Ohio Valley populations. I sampled a total of 370 individuals from 26 populations representing a lineage that inhabited the middle and upper Ohio valley region from approximately 3000 to 350 BP.

Evolutionary changes in the frequencies of morphological features of the deciduous teeth in this lineage were limited. Over 80% of the features show no significant differences among the populations. The relatively few features that show consistent differences separate pre- and postmaize agricultural populations. I discuss explanations for this change in terms of selection differences or gene flow.

The general pattern of morphological trait expression in the deciduous teeth of this Ohio Valley lineage corresponds to what has been termed the Mongoloid dental complex (sinodonty in the permanent teeth). I suggest additional features that, with further study, may be added to this morphological complex. Am J Phys Anthropol 106:189–205, 1998. © 1998 Wiley-Liss, Inc.

Almost nothing is known of the microevolutionary dynamics of morphological features of the human deciduous dentition. This situation has arisen primarily as the result of the difficulty in obtaining representative samples from a sequence of ancestral-descendant populations. Demographic biases, whether the result of differential preservation, poor recovery, or the cultural practices of a population, often limit the number of children representing a skeletal sample. In addition, the timing of the development and replacement of the deciduous teeth usually results in the loss of morphological information for many of the children available for study. However, while the documentation of evolutionary change in the deciduous dentition of any given lineage has been sketchy and incomplete, variation in the expression and frequency of morphological features of the deciduous teeth has been recorded for a number of human populations (Jorgensen, 1956; Hanihara, 1963, 1967: Smith, 1976, 1978; Sciulli, 1977, 1990a; Lukacs and Walimbe, 1984; Grine, 1986). These studies have shown that the morphology of the deciduous dentition of human populations exhibits significant within- and between-population variation and is thus potentially liable to microevolutionary forces.

The purpose of this investigation is to document and evaluate variation in the expression and frequency of 57 morphological features of the deciduous dentition in a lineage of Native Americans from the middle and upper Ohio Valley. The populations from which the samples are drawn come from an approximately 2,500 year span of the culture-historic development of the lineage. During

*Correspondence to: Paul W. Sciulli, Department of Anthropology, Ohio State University, Columbus, OH 43210. E-mail: sciulli.1@osu.edu

Received 4 June 1997; accepted 26 February 1998.

this time span, groups were initially relatively small and mobile without ceramics and subsisted primarily as hunter-gatherers. Through time, groups developed into larger, more sedentary populations with a well-developed ceramic technology and an agricultural subsistence base, at first utilizing plants native to the area and later focusing on introduced tropical cultigens. The populations representing this lineage during the period under study have thus experienced changes in subsistence, technology, and structure which are commonly associated with and have been hypothesized to cause microevolutionary changes in the permanent dentition (Brace et al., 1991). One of the principal questions to be addressed here is to what extent, if any, morphological variation in the deciduous teeth is associated with changes in the cultural accommodations of populations.

MATERIAL AND METHODS

Samples

I scored a total of 370 individuals for morphological features of the deciduous teeth. The individuals are sampled from 26 upper and middle Ohio Valley populations representing each culture-historic time period from the terminal Late Archaic (approximately 3000 BP) to the Late Prehistoric (approximately 350 BP). Table 1 contains a listing of the populations by time period and the number of individuals sampled from each. All populations are located in Ohio except for the Monongahela, located in adjacent western Pennsylvania, and Buffalo, located in adjacent West Virginia. Because a number of the samples are small and many individuals have incomplete data due to the nature of deciduous tooth development and replacement, I combined the Late Archaic samples into one group (n = 64) and the three Woodland samples into a second group (n = 34). The Late Prehistoric samples, except for Anderson Village, are treated separately. The Anderson Village sample is included only in calculations and statistics involving the total sample.

The general cultural features of the historical periods from which the populations in Table 1 are sampled have recently been presented, so only a brief review is necessary here (Sciulli, 1997). In the terminal Late Archaic period, populations can be characterized as relatively small, mobile, aceramic, primarily hunter-gatherers. Populations are associated with specific mortuary patterns, each of which has a generally exclusive geographical distribution. However, because Late Archaic habitation sites are unknown, the significance of the variation in mortuary behavior cannot be related to the general cultural context of the populations. During the Late Archaic period, plants native to the region were domesticated (Smith, 1989) and may have contributed to the diet of the populations under study. The frequencies of deciduous dental pathologies which relate most directly to diet (caries 0.88%, number of teeth = N_T = 793; abscess 0%, N_L = number of loci = 913; and antemortem loss 0%, N_L = 913) are minimal in these

TABLE 1. Population sampled from each culture-historical period of the middle and upper Ohio Valley region[1]

Late Archaic (N = 64) (approximately 3200 BP to 2700 BP)	
Kirian Treglia	(8)
Boose	(16)
Duff	(19)
Orleton	(3)
Scioto Country Homes	(2)
Davis	(7)
Williams Red Ocher	(4)
Muzzey Lake	(5)
Early Woodland (N = 20) (approximately 2700 BP to 2000 BP)	
Galbreath	(2)
McMurray	(2)
Sidner I	(2)
Sidner II	(9)
Cowan Creek	(3)
Niles Wolford	(1)
Teopfner	(1)
Middle Woodland (N = 9) (approximately 1900 BP to 1500 BP)	
Esch	(3)
Hopewell	(3)
Harness	(1)
Seip	(2)
Late Woodland (N = 5) (approximately 1500 BP to 1000 BP)	
Voss	(1)
Baker I	(4)
Late Prehistoric (N = 272) (approximately 1000 BP to 350 BP)	
Pearson Village	(48)
Anderson Village	(13)
Sun Watch	(76)
Monongahela	(62)
Buffalo	(73)

[1] Numbers in parentheses following site name is the sample size; N is the sample size for the period.

populations, reflecting the presumably small amount of simple carbohydrate in the diet. All samples included here are from the Glacial Kame or related cultural complexes (Griffin, 1983).

The beginning of the Early Woodland period in this area is defined by the introduction of ceramics. At first very thick and crude and probably used only for storage, pottery developed throughout the Woodland period with varieties well designed for cooking appearing toward the end of the Early Woodland and characterizing all subsequent periods. The Early Woodland period is also characterized by the elaboration of mortuary ceremonialism in the form of conical mound burial, often of an ornate nature, as well as the continued use of native domesticates. Many populations of this period in the area and all populations in the present sample are included in the rather poorly defined Adena mortuary complex which was widely distributed in the middle and upper Ohio Valley region (Webb and Baby, 1957).

Populations of the Middle Woodland period exhibited a further elaboration of mortuary ceremonialism. Large conical mounds often with burials accompanied by exotic goods are common in Middle Woodland contexts. These populations further developed native domesticates even though they, like Early Woodland populations, still relied heavily on hunting and gathering. The size of local populations appears to have gradually increased in both the Early and Middle Woodland periods. All of the Middle Woodland samples included in the present study are from Ohio Hopewell complex populations (Griffin, 1983).

Late Woodland populations are perhaps the most poorly known from any period. This may be because Late Woodland populations abandoned the elaborate mortuary ceremonialism characteristic of the Early and Middle Woodland periods (and even to some extent the Late Archaic period). Late Woodland populations, however, for the first time, begin to inhabit, at least periodically, relatively large, fortified villages (Dancey, 1988). Subsistence practices in the Late Woodland are very similar to those of the Middle Woodland.

Frequencies of deciduous dental pathologies in each of the Woodland periods are low and comparable to those in the Late Archaic period (Sciulli, 1997). These low frequencies of dental pathologies reflect the continued reliance on hunting and gathering and, despite the use of native cultigens, the lack of a source of high amounts of simple carbohydrates in the diet. The frequencies of deciduous dental pathologies in the combined Woodland sample are as follows: caries, 2.63%, $N_T = 228$; abscess, 0%, $N_L = 280$; antemortem loss, 0%, $N_L = 280$.

The Late Prehistoric period is defined on the basis of the introduction to the region of the tropical domesticates maize and beans. Although populations now focused subsistence activities on these new plants, native plant use continued, and hunting and gathering still provided a significant contribution to the diet. Populations, which appear to have been in general larger than in previous periods, usually inhabited sizable, pallisaded villages near their fields for at least part of the year. In this study, I sampled populations of three Late Prehistoric cultural groups: Fort Ancient in southwest Ohio and West Virginia (Anderson, SunWatch, and Buffalo), Monogahela in western Pennsylvania, and Sandusky in northwestern Ohio (Pearson) (Griffin, 1983; Stothers and Abel, 1989).

In the Late Prehistoric period, populations suffered an extreme deterioration of dental health (Sciulli, 1997). Presumably this was the result of the inclusion of large amounts of maize in the diet. In the deciduous dentition, the frequencies of pathologies, especially caries, increase dramatically compared to the previous periods: caries, 15.91%, $N_T = 2237$; abscess, 0.27%, $N_L = 2191$; antemortem loss, 0.41%, $N_L = 2191$.

The hypothesis that the samples included here represent an evolving population lineage is based on the analysis of adult cranial metrics (Sciulli, 1990b; Sciulli and Mahaney, 1990). It has been shown that for populations sampled from temporally adjacent time periods (e.g., Archaic–Middle Woodland, Middle Woodland–Late Woodland, etc.) cranial metrics exhibit homogeneous covariance structures. While there is some size difference among populations, the

essentially identical shape of the crania during the period under consideration indicates strongly that these populations were part of an evolving population or lineage. The pattern of evolution of these populations, inferred from cranial metrics, appears to be unilineal from the Late Archaic to the Late Woodland period. In the Late Prehistoric period, three regional populations appear (northwest, southwest, and southeast portions of Ohio), each, however, homogeneous with the Late Woodland population but differing from each other. The structure of the Late Prehistoric population suggests instability which may have arisen as the result of the introduction of maize accompanied by differential gene flow into the area (Tatarek and Sciulli, 1997).

Morphological features

From the samples described above I collected information on the nature and amount of variation of 57 morphological features of the deciduous dentition: 33 are features of the crown and 24 are root features. I scored both the left and right tooth of each individual for each feature if both teeth were present. However, if the expression of the feature were symmetrical, only one score represented the feature for the tooth in the individual. If an individual exhibited asymmetry of expression in a feature, the more complex expression was used to represent the feature for a tooth. If only one of an antimeric pair were present, the score for the feature of that tooth represented the individual. Thus, all frequencies and averages are based on counts per individual. I did not collect data from individuals for whom wear or pathologies affected the expression of a feature. In all subsequent descriptions of features and their variations, I use the following abbreviations: u, maxillary; l, mandibular; i, incisor; c, canine; 1, central; 2, lateral; m1, deciduous first molar; m2, deciduous second molar. The designation of the postcanine deciduous teeth as molars reflects only historical usage. Ontogenetically these teeth are premolars. Below is the list of the morphological features, the teeth for which each was scored, and the criteria used in scoring variations of the features. These explicit definitions should facilitate interobserver comparisons, as there is little agreement concerning the classification and interpretation of all morphological features of the deciduous teeth.

Shovel shape (ui1-uc and li1-lc). All anterior teeth are scored for the relative development of lingual marginal ridges using Hanihara's (1963) criteria.

0. Absent: lingual surface smooth.
1. Semishovel: slight elevation of marginal ridges.
2. Shovel: marginal ridges easily seen.
3. Strong shovel: marginal ridges broad and high.

Expressions 2 and 3 are defined to be the presence of shoveling and 0 and 1 to be absence of shoveling in calculating the frequency of this feature. This can be stated as p = 2–3/0–3, where 2–3 is the number of individuals in these two classifications, 0–3 is the total number of individuals scored, and p is the frequency of shoveling. The frequencies of all subsequent features will be in this form, and the definition of p will be simply stated. A weighted average expression, W, is also presented using all classes of expression: $W = \Sigma c_i x_i / \Sigma x_i$, where c_i is the class value and x_i is the number of individuals in the class.

Double shovel (ui1-uc). The maxillary anterior teeth are scored for the presence of labial marginal ridges.

0. Absent: labial surface smooth.
1. Mesial ridge present.
2. Distal ridge present.
3. Mesial and distal ridge present.

The development of the labial ridges is not scored, as they are generally not strongly expressed. For double shovel, p = 1–3/0–3. In calculating W, classes 1 and 2 are combined. Thus, for W, 0 = absent, 1 = one ridge, 2 = both ridges.

Winging (ui1). Variations in the alignment of the central incisors are scored using Dahlberg's (1963) criteria.

0. Absent: ui1's distal borders on straight line.

1. Unilateral wing: distal border of one ui1 toward labial.
2. Bilateral wing: both distal borders toward labial.

The frequency of winging is p = 1–2/0–3. In the present sample, neither winging nor counterwinging, where the distal border(s) is rotated toward the lingual, occurred, and W is not calculated. Lack of winging in the ui1 in these samples is likely due to the lack of crowding of the teeth (Dahlberg, 1963).

Interruption groove (ui1-ui2). The maxillary incisors are scored for the presence of grooves crossing the lingual cemento-enamel junction using the criteria of Turner et al. (1991).

0. Absent: no grooves present.
1. Mesiolingual (ML): one groove at ML.
2. Distolingual (DL): one groove at DL.
3. Medial: one groove centrally located.
4. ML and DL: two grooves, one ML and one DL.

The frequency of interruption grooves is p = 1–4/0–4. In the present samples, p = 0, and W is not calculated.

Tuberculum dentale (ui1-uc and lc). The maxillary anterior teeth and lc are scored for the presence and degree of development of elaborations in the area of the lingual cingulum and lingual fossa using Grine's criteria (1986). In the present scoring, elaborations in this area are distinguished from the size of the cingulum itself.

0. Absent: lingual surface smooth.
1. Pit(s) or groove(s) present.
2. One ridge present.
3. Two ridges present.
4. Free tubercle(s): strong ridge with free apex.

The frequency of tuberculum dentale is p = 1–4/0–4, and W uses all categories.

Mesial ridge (uc). The uc is scored for the presence or absence of a distal deflection of the mesial marginal ridge (Irish and Morris, 1996). P is the frequency of occurrence of the mesial marginal ridge, and W is not calculated.

Distal accessory ridge (uc, lc). The degree of expression of an accessory ridge on the lingual surface of the canines between the cusp apex and the distal marginal ridge is scored using the criteria of Turner et al. (1991).

0. Absent: no ridge present.
1. Faint.
2. Weak.
3. Moderate.
4. Strong.

The frequency of canine distal accessory ridge is p = 1–4/0–4 and W uses all categories. In scoring this feature, Turner et al. (1991) use five categories. Here 5 is dropped, as no canine expressed a very pronounced distal accessory ridge.

Cusp number, hypocone (um1). Cusp number and development of the upper anterior premolar are scored using Hanihara's (1963) criteria.

2. Eocone (eo) and protocone (pr) present (eo = paracone).

3M. Eo, pr, and metacone (me) present.
3H. Eo, pr, and hypocone (hy) present.
4−. All four cusps present but hy reduced.
4. All four cusps present but hy not reduced.

For um1 cusp number, classes 4− and 4 are presence of hy p = 4 + 4−/2–4. Three classes are used in calculating W: 2, 3 combining 3M and 3H, and 4 combining 4 and 4−.

Cusp number, hypocone (um2). The development of the posterior premolar's hypocone is scored using Hanihara's (1963) criteria.

3. Eo, pr, me, and a small distally placed hy.

4−. Eo, pr, and me attached to small hy by distal ridge.
4. Eo, pr, me, and large hy.

The frequency of um2 hypocone is p = 4 + 4−/3–4. Only two classes are used for W, 3 and 4, where the latter combines 4 and 4−.

Cusp 5 (um2). Accessory cusp located between the metacone and hypocone of the upper posterior premolar is scored as pre-

sent or absent. P is the frequency of occurrence of this cusp, and W is not calculated.

Carabelli's trait (um2). Elaborations of the mesiolingual surface of the upper posterior premolar are scored using Grine's (1986) criteria.

0. Absent: mesiolingual surface smooth.
1. Pit, groove: present.
2. Two grooves: roughly parallel grooves.
3. Welt: area between grooves raised, apex not free.
4. Cusp: same as 3 but apex free.

For Carabelli's trait, p = 2–4/0–4, and W uses all categories.

Cusp number (lm2). This feature is simply an enumeration of cusps present on the lower anterior premolar.

2. Eoconid (eod) and metaconid (med) (eod = protoconid).
3. Eod, med, and hypoconid (hyd).
4. Eod, med, hyd, and entoconid (end).
5. Eod, med, hyd, end, and hypoconulid (hyld)

6–8. Accessory cusps on distal marginal ridge.

For lm1 cusp number, p = 5–8/2–8, and W uses all categories.

Groove pattern (lm2). The relationship among the principal cusps of the lower posterior premolar is scored. The relationships yield the following groove patterns:

1. +: eod and end in contact.
2. X: eod and end in contact.
3. Y: med and hyd in contact.

For lm2 groove pattern, p = 3/1–3, and W uses all categories.

Hypoconulid (lm2). The distal cusp of the lower posterior premolar is scored as present or absent. P is the frequency of the presence of the hypoconulid. W is not calculated.

Deflecting wrinkle (lm2). The course of the medial ridge of the metaconid of the lower posterior premolar is scored as straight or deflected toward the distal. P is the frequency of occurrence of the deflected medial ridge. W is not calculated.

Protostylid (lm2). The development of elaborations of the mesiobuccal surface of the lower posterior premolar is scored using Grine's (1986) criteria.

0. Absent: mesiobuccal surface smooth and buccal groove present.
1. Groove: horizontal or oblique fissure present.
2. Cusp: fissure(s) delineates swelling with free apex.

For the protostylid, p = 1–2/0–2, and W uses all categories. The presence or absence of the buccal pit is not considered in these criteria.

Cusp 6, tuberculum sextum (lm2). The development of an accessory cusp (C6) located between the hyld and end is scored using the criteria of Turner et al. (1991).

0. Absent: no accessory cusp present.
1. Hyld >> C6.
2. Hyld > C6.
3. Hyld = C6.
4. Hyld < C6.
5. Hyld << C6.

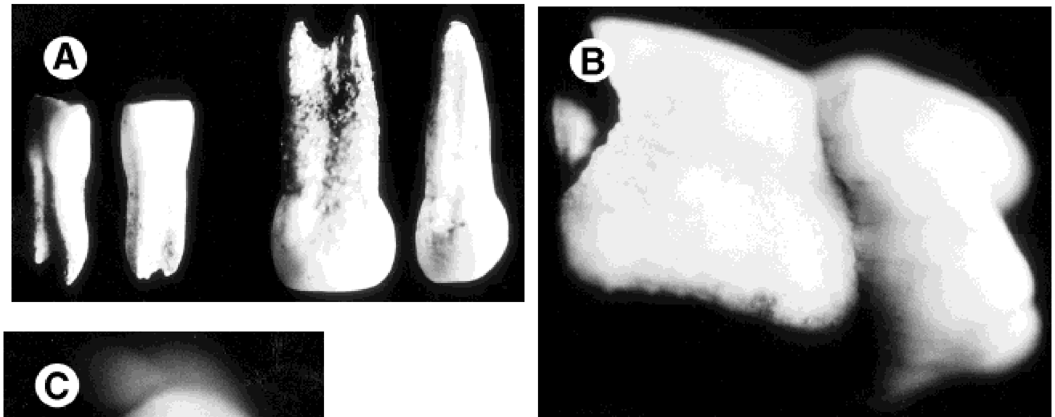
For cusp 6, p = 1–5/0–5, and W uses all categories.

Cusp 7, tuberculum intermedium (lm2). The development of an accessory cusp (C7) located between the med and end is scored as follows:

0. Absent: no accessory cusp present.
1. Hyld >> C7.
2. Hyld > C7.
3. Hyld = C7.
4. Hyld < C7.
5. Hyld << C7.

For cusp 7, p = 1–5/0–5, and W uses all categories.

Distal trigonid crest (lm2). The presence or absence of a continuous ridge from the distal border of the eod to the distal border of the med is noted (Turner et al.,



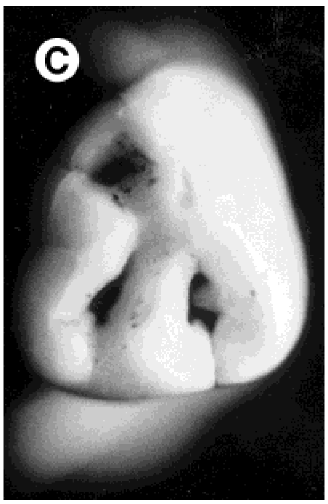


Fig. 1. Morphological variants of the deciduous dentition. **A:** Root grooves, left to right: right li1, left li1, left ui1, and left ui2; ui2 shows minimal expression of root groove scored as absent. **B:** Root sheath left um2. Monongahela individual FC 3765. **C:** Delta form right lpa. Monongahela individual FC 2215. SunWatch individual 3/72.

1991). P is the frequency of the occurrence of the continuous ridge. W is not calculated.

Delta form (lm1). A triangular occlusal outline of the lower anterior premolar is scored as present or absent (Dahlberg, 1949). When present, the triangular or delta form anterior premolar is broad distally, tapering to a mesial apex. In the present sample, this feature is accompanied by a ridge extending from the distal marginal ridge into the talonid basin (Fig. 1C). P is the frequency of occurrence of the delta form. W is not calculated.

Double teeth (li1-lc). The presence or absence of fusion-gemination of the lower anterior teeth is noted. Because it is not always apparent whether fusion or gemination occurred, these cases will be referred to as double teeth (Stevenson, 1985). To be counted, an individual must have at least a li2 since virtually all cases included li1-li2 or li2-lc.

Root number (all teeth). All observations of the roots of the deciduous teeth were made on teeth extracted from the jaws. The number of roots is counted for each tooth in individuals whose roots were completed (apices may have been open). For anterior tooth roots to be counted as double, separation between the roots must have extended for at least one-quarter of the distance from the apical end. Anterior teeth are scored as 1 or 2 rooted, and p = 2/1–2. Maxillary premolars (um1 and um2) are scored as 2, 3, or 4 rooted and mandibular premolars (lm1 and lm2) as 2 or 3 rooted. The 3 rooted mandibular premolars exhibit an accessory distolongual root (Turner, 1971). For maxillary premolar root number, p = 2/2–4, and for mandibular premolar root number, p = 3/2–3. W is not calculated for root numbers.

Root groove (anterior teeth). The anterior teeth exhibit a variation wherein in-

stead of a simple conical root the root is expanded in the mesiodistal direction (flattened) and exhibits a marked vertical buccal groove (Fig. 1A). The roots of these teeth often have two apices (Sciulli, 1990a). For all anterior teeth, p is the frequency of occurrence of the buccal groove. W is not calculated.

Root sheath (um1, um2). A thin sheet of cementum may connect the distobuccal and lingual roots of the upper premolars (Jorgensen, 1956) (Fig. 1B). This feature can be noted prior to root completion as the connection begins at the base of the roots (and usually extends almost to the apex). For both upper premolars, p is the frequency of occurrence of the root sheath. W is not calculated.

Labial deflection (anterior teeth). The presence or absence of a labial orientation of the roots of the anterior teeth (Jorgensen, 1956) was scored if the roots were complete (see above). To be considered present, the apical half of the root at least must exhibit any degree of labial tilt. P is the frequency of occurrence of labial deflection, and W is not calculated.

Heterogeneity of frequencies among the samples is tested by the G-test (Sokal and Rohlf, 1981) using the dichotomized data (the presence of a feature is the same as the definition of the numerator given for p for the feature). All features are tested for association using X^2 or Fisher's Exact Test (Sokal and Rohlf, 1981). For the majority of features, the entire sample is used for testing associations (see below). Finally, the mean measure of divergence (mmd) between samples is calculated using independent features (de Souza and Houghton, 1977). The matrix of mmds is graphically displayed using principal coordinates analysis (Marida et al., 1979).

RESULTS

Tables 2 and 3 contain the frequencies and weighted average expressions for 41 of the 57 morphological features of the deciduous dentition in the Ohio Valley samples. Nine features are not included in these tables because they exhibit no variation in the total sample, while another five features are not included because they exhibit extremely little variation. These 14 features with little or no variation are listed in Table 4. Root numbers of um1 and um2 are not listed in Table 2 because the presence of a root sheath is equivalent to the expression of two roots and its absence is equivalent to the expression of three roots.

Shoveling

Shoveling of the anterior teeth is both frequent and well expressed in the Ohio Valley samples. Among the six samples, only li1 ($G_5 = 12.18$) and li2 ($G_5 = 16.64$) shoveling exhibit heterogeneity. In both cases the differences are due to the relatively high frequencies of shoveling in the Woodland sample and the low frequency of shoveling in the Pearson sample. Because the remaining anterior teeth show no differences in the frequency of shoveling and because the sizes of the Woodland and Pearson samples are relatively small for li1 and li2, there is a strong possibility that the observed heterogeneity for shoveling in these two teeth is the result of sampling effects and not indicative of true differences.

Shoveling in the total sample is most frequent and strongly expressed in ui2, uc, and lc. The mandibular incisors, especially li1, exhibit the lowest frequency of shoveling and the weakest expression, while ui1 is intermediate in both measures.

For the total sample and in the Woodland and Pearson samples, shoveling shows strong associations between anterior teeth. The maxillary incisors are significantly associated with each other but independent of the canines, while the mandibular incisors are associated with each other, the maxillary incisors, and the mandibular canine. Shoveling of the maxillary canine is the only feature independent of shoveling in all other anterior teeth. Associations between shoveling and other features in the total sample are as follows: ui1-ui1 double shovel (negative association), li1-ui2 tuberculum dentale and um1 cusp number (negative association), li2-um2 Carabelli trait, lc-lm2 root number (negative association), lc root groove, and um2 root sheath.

TABLE 2. Frequencies of morphological features of the maxillary deciduous dentition in prehistoric Ohio Valley samples[1]

		Archaic			Woodland			Pearson			SunWatch			Monongahela			Buffalo			Total			
Tooth	Trait	N	%	W	N	%	W	N	%	W	N	%	W	N	%	W	N	%	W	N	%	CI	W
ui1	Shovel	34	73.5	1.97	20	75.0	2.10	22	72.7	1.95	37	78.4	2.19	25	80.0	1.88	17	82.4	1.94	163	77.3	70.9 83.7	2.01
	Double shovel	32	15.6	0.16	20	35.0	0.40	20	15.0	0.15	34	5.9	0.06	27	33.3	0.41	16	37.5	0.44	157	20.4	14.1 26.7	0.23
	Tuberculum dentate	33	15.1	0.42	20	5.0	0.10	19	5.3	0.05	33	12.1	0.24	26	15.4	0.27	17	17.6	0.35	155	11.6	6.6 16.6	0.25
	Root groove	24	58.3	—	13	84.6	—	16	18.8	—	17	52.9	—	13	69.2	—	14	35.7	—	105	54.3	44.8 63.8	—
	Labial deflection	24	54.1	—	13	76.9	—	16	25.0	—	17	64.7	—	12	25.0	—	13	38.5	—	103	47.6	38.0 57.2	—
ui2	Shovel	33	87.9	2.06	18	100	2.17	19	84.2	2.00	37	91.9	2.38	18	94.4	2.22	14	100	2.21	147	92.5	88.2 96.8	2.18
	Double shovel	32	3.1	0.03	18	33.3	0.33	19	5.3	0.05	34	2.9	0.03	18	22.2	0.39	14	14.3	0.14	143	10.5	5.5 15.5	0.13
	Tuberculum dentate	32	15.6	0.44	18	5.6	0.22	17	17.6	0.35	34	14.7	0.32	18	22.2	0.28	13	23.1	0.46	139	15.1	9.1 21.1	0.33
	Labial deflection	23	4.3	—	12	25.0	—	16	6.2	—	16	6.2	—	9	0	—	12	16.7	—	96	9.4	3.6 15.2	—
uc	Shovel	34	88.2	2.02	23	82.6	2.04	18	83.3	2.11	33	90.9	2.27	27	88.9	2.11	20	90.0	2.15	162	87.7	82.6 92.8	2.12
	Double shovel	34	14.7	0.24	23	13.0	0.13	18	11.1	0.11	31	3.2	0.03	27	3.7	0.04	18	16.7	0.28	158	9.5	4.9 14.1	0.13
	Tuberculum dentate	34	35.3	1.00	23	26.1	0.74	23	52.2	1.09	33	54.5	1.00	28	57.1	1.07	23	52.2	0.96	171	45.6	38.1 53.1	1.02
	Distal accessory ridge	33	27.3	0.73	15	40.0	0.93	20	35.0	0.95	34	20.6	0.53	21	52.4	1.67	21	9.5	0.24	150	30.0	22.7 37.3	0.82
	Root groove	25	60.0	—	17	64.7	—	21	14.3	—	15	40.0	—	23	47.8	—	16	31.3	—	123	44.7	35.9 53.5	—
	Labial deflection	24	12.5	—	17	47.1	—	21	42.9	—	14	64.3	—	23	30.4	—	16	25.0	—	120	33.3	24.9 41.7	—
um1	Cusp number	44	25.0	3.00	27	40.7	3.30	25	40.0	3.28	34	64.7	3.65	30	73.3	3.73	19	68.4	3.68	188	49.5	42.4 56.6	3.22
	Root sheath	38	57.9	—	17	52.9	—	28	64.3	—	19	84.2	—	29	55.2	—	26	53.8	—	165	59.4	51.9 66.9	—
um2	Cusp 5	42	38.1	—	26	23.1	—	29	24.1	—	32	25.0	—	36	22.2	—	32	25.0	—	206	26.7	20.7 32.7	—
	Carabelli	44	13.6	0.82	27	11.1	0.93	30	30.0	1.17	30	26.7	1.17	40	25.0	1.15	36	33.3	1.17	217	22.6	17.0 28.2	1.05
	Root sheath	28	32.1	—	16	25.0	—	26	30.8	—	13	30.8	—	27	22.2	—	19	0	—	133	25.6	18.2 33.0	—

[1] CI, confidence interval; N, sample size; W, weighted expression; %, frequency.

Double shovel

Labial shoveling of the maxillary anterior teeth is much less frequent than lingual shoveling and even when present is not strongly expressed. The most frequent manifestation of this feature is a single mesial ridge. The presence of a mesial and distal ridge is the least common expression of double shoveling (<2%).

Among the six samples, ui1 ($G_5 = 13.72$) and ui2 ($G_5 = 15.04$) show significantly heterogeneity. In the former case, heterogeneity is due to the low frequency of double shovel in the SunWatch sample, while in the latter case it is due to the high frequencies in the Woodland and Monongahela samples.

In the total sample and in the combined Woodland and Monongahela samples, double shovel of each anterior tooth is associated with each other anterior tooth. Associations between double shovel and other features in the total sample are as follows: ui1-uc distal accessory ridge, um1 cusp number, um2 Carabelli trait and ui2-uc distal accessory ridge, um2 Carabelli trait.

Tuberculum dentale

There are no differences among the samples for the frequency of this feature. In the total sample, the maxillary canine expresses tuberculum dentale most frequently and strongly. Tuberculum dentale is rare and weakly expressed on the mandibular canine, while the upper incisors show a somewhat higher frequency and stronger expression. Only the upper canine (14.6%)

TABLE 3. Frequencies of morphological traits of the mandibular deciduous dentition in prehistoric Ohio Valley samples[1]

		Archaic			Woodland			Pearson			SunWatch			Monongahela			Buffalo			Total			
Tooth	Trait	N	%	W	N	%	W	N	%	W	N	%	W	N	%	W	N	%	W	N	%	CI	W
li1	Shovel	29	48.3	1.28	16	62.5	1.44	12	8.3	1.00	31	45.2	1.42	14	28.6	1.21	11	27.3	1.18	118	38.9	30.1 47.7	1.25
	Root groove	21	4.8	—	16	6.2	—	9	11.1	—	18	5.6	—	12	16.7	—	10	0	—	92	6.5	1.5 11.5	—
	Labial deflection	22	18.2	—	15	6.7	—	9	0	—	18	0	—	12	0	—	10	0	—	91	5.5	0.80 10.2	—
il2	Shovel	33	66.7	1.55	20	95.0	2.20	18	38.9	1.39	35	68.6	1.74	20	65.0	1.75	15	53.3	1.53	147	65.3	57.6 73.0	1.67
	Root groove	23	13.0	—	15	6.7	—	16	18.8	—	17	23.5	—	16	25.0	—	8	37.5	—	100	18.0	10.5 25.5	—
	Labial deflection	23	13.0	—	15	0	—	16	12.5	—	17	5.9	—	16	0	—	8	0	—	101	5.9	1.3 10.5	—
lc	Shovel	41	87.8	2.12	20	100	2.15	15	93.3	2.47	33	97.0	2.55	20	100	2.60	14	64.3	1.79	150	90.7	86.1 95.3	2.25
	Tuberculum dentate	39	5.1	0.13	20	10.0	0.15	16	0	0	31	3.2	0.06	16	6.2	0.06	15	6.7	0.13	144	5.6	1.8 9.4	0.10
	Distal accessory ridge	38	5.3	0.16	18	22.2	0.44	16	12.5	0.44	31	3.2	0.13	17	5.9	0.18	17	23.5	0.47	144	11.1	6.0 16.2	0.28
	Root groove	24	20.8	—	15	26.7	—	19	42.1	—	13	38.5	—	20	65.0	—	11	36.4	—	106	38.7	29.4 48.0	—
	Labial deflection	23	26.1	—	15	20.0	—	19	36.8	—	13	53.8	—	21	33.3	—	11	9.1	—	107	29.0	20.4 37.6	—
lm1	Cusp number	40	77.5	5.02	24	70.8	4.96	26	61.5	4.69	40	80.0	5.25	40	70.0	4.80	35	71.4	4.80	214	72.0	66.0 78.0	4.94
	Delta form	41	24.3	—	25	24.0	—	26	15.4	—	40	22.5	—	43	30.2	—	35	11.4	—	219	21.9	16.4 27.4	—
	Disto-lingual root	31	9.7	—	15	6.7	—	28	14.3	—	18	0	—	34	8.8	—	28	0	—	159	6.9	3.0 10.8	—
lm2	Deflecting wrinkle	44	61.4	—	23	69.6	—	35	91.4	—	35	88.6	—	38	92.1	—	39	89.7	—	223	82.1	77.1 87.1	—
	Protostylid	47	34.0	0.45	26	38.5	0.50	36	30.6	0.42	35	25.7	0.40	38	15.8	0.18	42	33.3	0.48	233	28.3	22.5 34.1	0.39
	C6	46	45.6	1.41	26	46.2	1.27	35	34.3	0.60	36	41.7	0.72	38	44.7	0.89	40	47.5	1.12	230	43.9	37.5 50.3	1.03
	C7	45	24.4	0.42	26	11.5	0.31	35	48.6	1.43	36	72.2	2.06	38	47.4	1.13	41	70.7	1.73	230	47.4	40.9 53.9	1.20
	Groove pattern	37	91.9	2.84	24	100	3.00	34	94.1	2.88	30	93.3	2.90	36	91.7	2.86	35	88.6	2.83	203	93.1	89.6 96.6	2.88
	Disto-lingual root	30	13.3	—	15	6.7	—	32	9.4	—	13	0	—	32	0	—	32	9.4	—	159	6.9	3.0 10.8	—
li1-li2-lc double teeth		35	2.9	—	20	0	—	22	4.5	—	69	7.2	—	28	0	—	49	2.0	—	231	4.3	1.7 6.9	—

[1] CI, confidence interval; N, sample size; W, weighted expression; %, frequency.

exhibits a free tubercle at a frequency greater than 5%.

The upper canine and ui1 show a significant association for the presence of the tuberculum dentale. Associations between tuberculum dentale and other features are as follows: ui2-uc root groove, uc-uc distal accessory ridge, um1 cusp number, lm1 cusp number (negative association), lm2 cusp 7, lm1 root number, lc-uc distal accessory ridge, lc distal accessory ridge, um1 cusp number, lm2 cusp 7, ui1 root groove.

Distal accessory ridge

The frequency of the canine distal accessory ridge (uc, lc) is homogeneous among the

TABLE 4. Features of the deciduous dentition exhibiting little or no variation in the Ohio valley samples[1]

Morphological feature	Tooth	N	%
Winging (+)	ui1	137	0
Interruption groove (+)	ui1	161	0
	ui2	149	0
Mesial ridge (+)	uc	154	0
Root groove (+)	ui2	98	0
Root number (>1)	ui1	105	0
	ui2	98	0
	li1	91	0
	li2	100	0
Cusp number (<4)	um2	222	0.5
Hypoconulid (−)	lm2	233	0.4
Distal trigonid crest (+)	lm2	188	1.1
Root number (2)	uc	122	1.6
	lc	109	0.9

[1] (+), present; (−), absent.

six samples. In general, uc exhibits both a higher frequency and stronger expression of this accessory ridge than the lower canine. However, the presence of this feature is strongly associated in the upper and lower canines.

Associations between the distal accessory ridge and other features are as follows: uc-um1 cusp number, lm1 cusp number, um2 Carabelli trait, lc-lm1 cusp number, lm2 deflecting wrinkle (negative association).

Cusp number um1

Cusp number of um1 exhibits significant heterogeneity among the six samples ($G_5 = 25.86$). In this case, the pattern of variation suggests the differences may not be due to sampling. The frequency of four cusps is relatively low in the Archaic, Woodland, and early (approximately 950–850 BP) Late Prehistoric Pearson samples and approximately doubles in frequency in samples from later agricultural populations. In both the earlier and later groups, the presence of four cusps on um1 is associated with lm1 cusp number, um2 Carabelli trait, and lm2 protostylid.

Cusp 5 um2

The frequency of this feature is homogeneous among the samples and achieves a moderate frequency in each. The occurrence of cusp 5 is independent of all other features.

Carabelli trait

Carabelli's trait tends to increase in frequency and show a stronger expression over time in the Ohio Valley samples. Much of the variation between samples is, however, limited to the expression of the double fissure which becomes more frequent in the Late Prehistoric populations. While there is a tendency for an increase in frequency of this feature over time, there are no significant differences among the samples. Carabelli trait is associated with lm1 cusp number.

In the present scoring scheme, Carabelli trait presence is defined as double fissure, welt, or cusp, and this classification has a low to moderate frequency in the samples. However, in all samples the pit-groove expression is much more frequent (50.7% in the total sample) and shows no tendency to change over time.

Cusp number lm1

Five is the modal cusp number for lm1 in the Ohio Valley samples. Reduction of cusp number (28%) is slightly more frequent than augmentation (20%). The frequency of lm1 cusp number is homogeneous in the samples.

Lm1 cusp number is associated with the following features: lm2 protostylid, lm1 delta form (negative association), lm1 root number (negative association), ui1 root groove, and root sheath of both um1 and um2.

Groove pattern lm2

The Y pattern (Y-5) is the dominant expression of this feature. The plus (+) pattern (5%) is somewhat more frequent than the X pattern (2%), but both are sporadic in occurrence. This feature is homogeneous among the samples. Because of the virtual fixation of the Y pattern, I did not test this feature for associations.

Deflecting wrinkle

The presence of a deflecting wrinkle increases significantly among the Late Prehistoric agricultural groups ($G_5 = 21.06$). It is only in this latter grouping that the deflecting wrinkle shows an association with lm2 cusp 7.

Protostylid

This feature is homogeneous among the six samples. In each sample the frequency of the horizontal-oblique fissure is greater than that of the cusp. In the total sample, the frequency of the fissure is 19.7%, while the frequency of the cusp is 8.6%.

The presence of the protostylid is negatively associated with the uc and li2 root groove.

Tuberculum sextum

While the frequency of C6 shows no significant differences among the samples, the degree of expression of this feature is generally greater in the Archaic and Woodland samples than among the Late Prehistoric samples. C6 is independent of all other features.

Tuberculum intermedium

The frequency of C7 is heterogeneous among the samples ($G_5 = 43.78$). The earlier Archaic and Woodland samples have frequencies of C7 less than 25%, while the Late Prehistoric samples show at least twice this frequency. In both the earlier and latter groups, however, the presence of C7 is negatively associated with ui1 root groove.

Delta form

The frequency of the delta form lm1 is homogeneous in the six samples. This feature achieves a moderate frequency in each sample and is associated with lm1 root number.

Double teeth

The occurrence of double teeth is sporadic in most of the Ohio Valley samples. The exceptions appear to be the SunWatch (5/69) and Anderson Village (2/6) samples, both representing the Fort Ancient Tradition and both located in southwest Ohio. When compared to all other samples (1.99%), the combined SunWatch–Anderson Village sample (9.33%) exhibits a significantly higher frequency of double teeth. Because of the generally low frequency of this feature, tests for associations were not performed.

Root number

As stated above, root number for the deciduous incisors shows no variation (all single rooted), and the canines only rarely exhibit a double root. Root number for the upper premolars (um1, um2) will be considered below under root sheath.

The mandibular premolars (lm1, lm2) each exhibit an accessory distolingual root at a frequency of 6.9% in the total sample. Because of the reduced sample sizes for this feature and the low frequency, tests for heterogeneity or associations were not performed.

Root sheath

The maxillary premolars (um1, um2) each exhibit the root sheath, with um1 sheath (59.4%) being about twice as frequent as um2 sheath (25.1%). There is no heterogeneity among the samples for this feature. As the presence of the sheath is equivalent to two roots and its absence is equivalent to three roots, root number of the upper premolars is also homogeneous. Four roots (and no sheath) occurs sporadically in um1 (0.6%) and um2 (4.5%).

Um1 and um2 are strongly associated for the presence of the root sheath. Um1 root sheath also shows a negative association with lc root groove.

Root groove

The presence of the buccal root groove is most common on ui1 and the canines. This feature is generally rare on the lower incisors and is absent on ui2. Ui1 and uc exhibit heterogeneity for this feature ($G_5 = 17.20$ and $G_5 = 15.41$, respectively). In both cases the frequency of the root groove is somewhat higher in the Archaic and Woodland samples, but the source of heterogeneity is the relatively small Pearson sample.

In the total sample and in the combined Archaic-Woodland sample, ui1 and uc root groove are strongly associated.

Labial deflection

As with the buccal groove, the presence of labial deflection is most common for ui1 and the canines. Ui1 labial deflection exhibits heterogeneity among the samples, but again the source of the heterogeneity is the small Pearson (and Monongahela) sample. Because sample sizes are reduced for this feature, tests for associations were not performed.

Tables of the counts of each expression for all traits in each sample are available on request.

In order to evaluate patterns of variation in the frequency of deciduous morphological traits in the Ohio Valley samples, I calculated the mean measure of divergence between each sample and performed principal coordinates analysis on the resulting distance matrix. For this analysis, 13 independent features were used: ui1 and uc shovel, ui2 double shovel, ui1 tuberculum dentale, lc distal accessory ridge, um1 cusp number and root sheath, um2 C5, lm2 C6, C7, and root number (distolingual root), lm1 delta form, and uc root groove. This set of features includes two which show systematic differ-

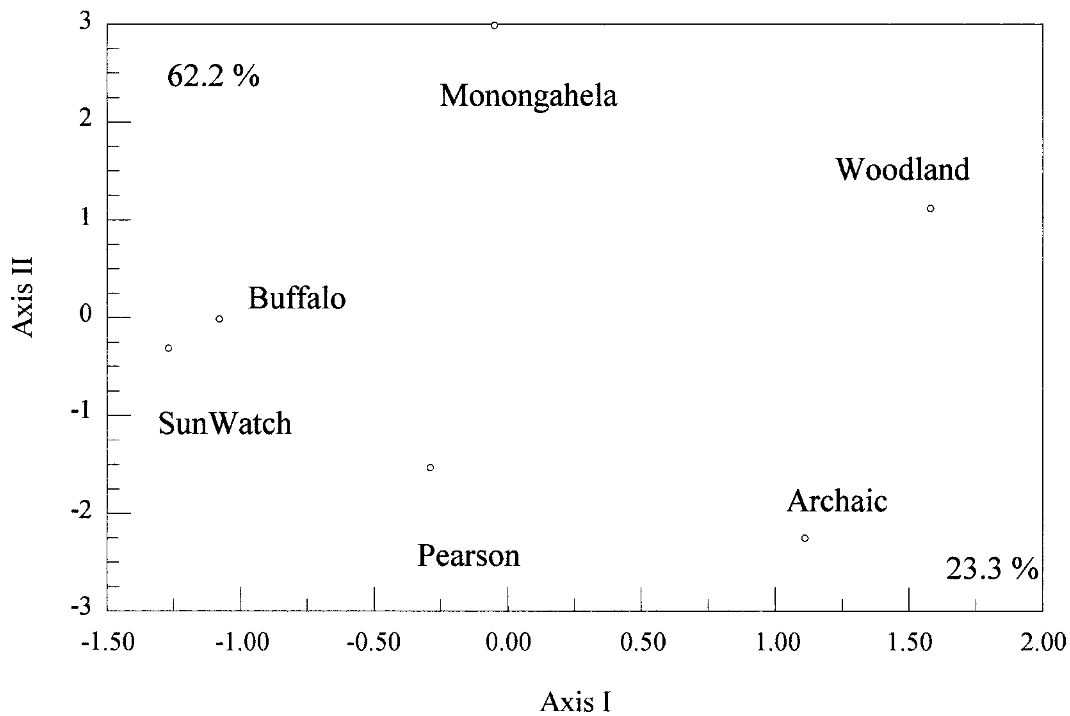


Fig. 2. Principle coordinates analysis of mean measures of divergence between Ohio Valley populations.

ences among the samples (um1 cusp number and lm2 C7) and two features which show differences that may be due to sampling (ui2 double shovel and uc root groove). In this set of 13 features, approximately 30% of the features shows some differences among the samples. This proportion of differences should reflect the variation in the total set of features in which about 20% exhibit some differences among the samples.

Figure 2 is the plot of the first two axes from the principal coordinates analysis. In this figure, a basic dichotomy appears to occurs along axis 1: a contrast between Late Prehistoric samples on the left and earlier Archaic and Woodland samples toward the right. Axis 1 also shows that among the Late Prehistoric samples, SunWatch and Buffalo, both representing Fort Ancient populations, cluster very closely. Axis 2 separates Archaic from Woodland populations and non–Fort Ancient Late Prehistoric populations from the Fort Ancient cluster. Although not presented, a correspondence analysis (Greenacre, 1984) of the 13 frequencies produced a similar pattern of differences among the samples, and the first two axes accounted for a similar amount of the total variation (73.1%). As might be expected from Tables 1 and 2, the first axis of the correspondence analysis revealed that the Late Prehistoric populations are most closely associated with lm2 C7, while the Archaic and Woodland populations are associated with uc root groove. Axis 2 shows an association of the Woodland sample with ui2 double shovel and the Archaic sample with lm2 root number and um1 root sheath.

Figure 3 contains the result of a correspondence analysis based on six features and 12 samples: the six Ohio Valley samples and six comparative samples. This analysis is limited to six features, as these features have been scored in a common manner (Grine, 1986). The data for the comparative samples are from American white, American Black, and Japanese (Hanihara, 1963), Medieval Danes (Jorgensen, 1956), South African

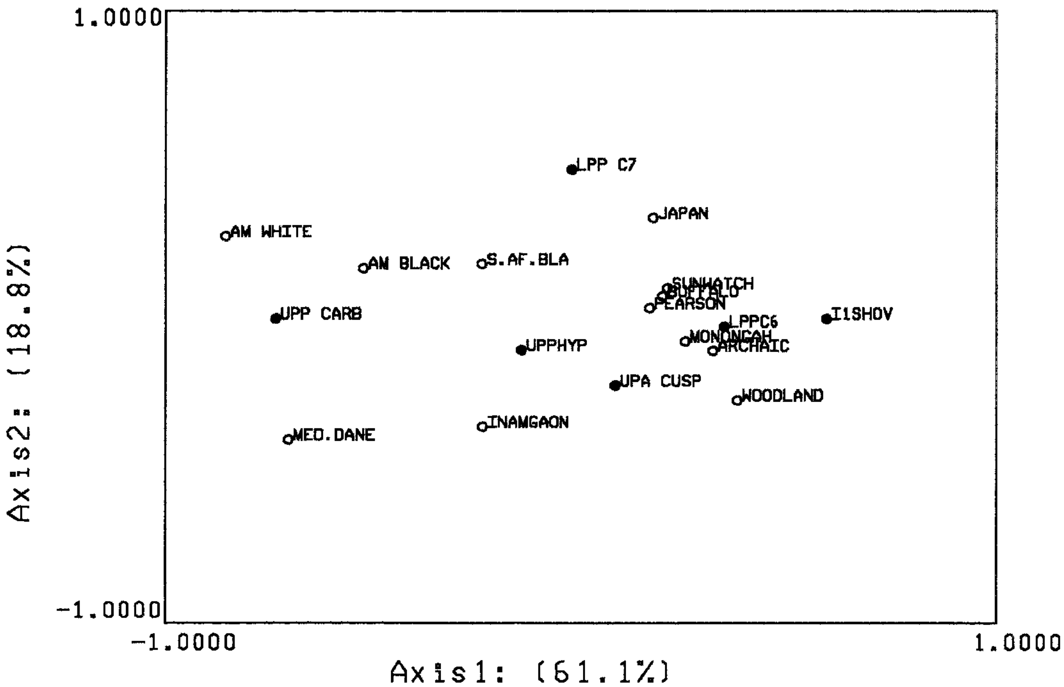


Fig. 3. Correspondence analysis of frequencies of morphological features of the deciduous dentition in Ohio Valley and comparative populations.

blacks (Grine, 1986), and Prehistoric Ingamoan (Luckas and Walimbe, 1984). For the Medieval Danes, ui1 shovel is not recorded, and a frequency of 0% is assumed for this sample.

Axis 1 in Figure 3 separates East Asian and derived populations (Ohio Valley) toward the right of the plot, associated with ui1 shovel, lm2 C6, and um1 cusp number (hypocone), while the European and African (and African-derived) populations are located to the left of the plot and associated with Carabelli's trait. Lm2 C7 and um2 cusp number (hypocone) are similar in frequency among the samples and are thus located toward the center of the plot not associated with any divergence among populations. Axis 2 appears to separate recent populations, toward the top of the plot, from populations earlier in time.

DISCUSSION AND CONCLUSIONS

The frequencies and degree of expression of morphological features of the deciduous teeth in the Ohio Valley lineage were generally conservative. Within the 2,500 year span considered, 46 of the 57 features investigated show no statistically significant differences among the samples. Of the 11 features that do show significant differences, eight exhibit deviations expressed by one or two populations with small samples for the feature, and these deviations are thus likely to be the result of sampling effects.

This observed stasis or in fact minor fluctuations around average frequencies for most features could have been the result of stabilizing selection acting within small populations or genetic drift acting within larger populations. Since archaeological evidence indicates that the lineage during this period was composed of relatively large, interacting populations and since the deciduous teeth have a limited functional exposure to the environment and thus a limited liability to the direct effects of selection, drift is the more likely cause of the minor fluctuations in the frequencies of most of the features of the deciduous teeth in the Ohio Valley lineage.

Although the vast majority of morphological variations exhibits only minor fluctuations in frequency over time in this lineage, three features (um1 cusp number and lm2 deflecting wrinkle and C7) show significant, consistent differences among the samples each increasing in frequency in the Late Prehistoric period. The increase in frequency of these three features is associated with the transition (approximately 1000 BP) during which populations changed from a subsistence base in which native cultigens made a major contribution to a subsistence base dominated by the introduced tropical domesticates maize and beans. The magnitude of the differences in these three features is sufficient to allow discrimination between pre- and post-1000 BP populations.

As will be shown in a future report, the size of the deciduous teeth in this lineage did not change significantly from the Late Archaic to the Late Prehistoric period. There are thus two likely explanations for the changes in the frequencies of morphological variations which occurred at this transitional period: changes in selective forces and gene flow. Postulating changes in selection for this period is not unreasonable, as populations were relatively large and major environmental changes (diet, settlement, ecology) were occurring (Sciulli, 1997; Tatarek and Sciulli, 1997; Fritz, 1990). If selection were the cause of the change in frequencies, the increase in frequency of four cusped um1 and lm2 deflecting wrinkle and C7 in the Late Prehistoric populations may have been the result of selection against these expressions. All individuals in the samples died prior to reproduction. The samples thus contain individuals representing background mortality and potentially individuals upon whom selection was acting based on characteristics other than the dentition as well as individuals upon whom selection was acting based on dental morphology either directly or indirectly. The morphological variations in the sample may thus represent to some degree the features conferring a lower fitness. Other scenarios based on selection may also be postulated, but at present any hypotheses based on these ideas cannot be tested, as the morphology of the deciduous teeth of individuals who survived childhood cannot be determined. However, since these changes occurred very quickly (compared to the total time span) and are limited to three features, differences in selection may not be the most likely explanation.

The second mechanism that may explain the morphological changes in the deciduous teeth at the transition to the Late Prehistoric period is gene flow. The introduction of maize and beans to the middle and upper Ohio Valley (approximately 1000 BP) may have been accompanied by the introduction of genes either by diffusion or by migration and diffusion from a population(s) to the west or south of the region. Evidence indicating an introduction rather than a gradual development includes the fact that the Early agricultural populations of the region, representing the Fort Ancient Tradition, show an abrupt change in agricultural and settlement patterns at this time. From the outset, Fort Ancient assemblages contain little evidence of the native seed crops common in Middle and Late Woodland assemblages of the area but rather an abundance of maize and beans (Fritz, 1990). This change in subsistence is accompanied by the presence of large villages and a marked degree of nucleation, both features distinguishing these populations from earlier groups as well as from many contemporaneous groups. In addition, the uniformity among Fort Ancient maize assemblages (Eastern Eight-row maize) indicates a single source of seed rather than a series of genetic sources (Wagner, 1987). The clustering of the Fort Ancient samples in Figure 2 (SunWatch and Buffalo) and the similarity in the archaeological assemblages of Fort Ancient sites suggest that both maize and genes may have been derived from a single source.

The incidence of double teeth also appears to support this scenario. Double teeth are generally rare in human populations. Surveys of European and North American children have determined that in these populations the frequency of double teeth never exceeded 1% and averaged about 0.5% (Brook and Winter, 1970). An exception to this general low frequency was found however among Japanese children, who expressed double teeth at a frequency of 4.95% (Saito, 1959).

The frequency of double teeth in Ohio Valley populations is low (approximately 2%) until the Late Prehistoric period, when this feature appears in southwestern Ohio at frequencies approaching 10%. But, away from southwest Ohio in the Late Prehistoric period, toward the north and east, the frequency of double teeth remains low (approximately 2%). Stevenson (1985) has documented a relatively high frequency of double teeth (6.38%) in the deciduous dentition at Averbuch, a Mississippian population from the area around Memphis, Tennessee. Since populations to the west and south of the middle Ohio Valley are a likely source from which maize and beans were introduced, they may also be the source of the increased frequencies of double teeth and other morphological variants of the deciduous dentition which appear at this time. This idea of gene flow may be evaluated more easily than selection alternatives by surveying populations to the west and south of the middle Ohio Valley for the frequency of double teeth, um1 cusp number, and lm2 deflecting wrinkle and C7.

The hypotheses stated above, while based on the present evidence, must be considered tentative. Additional samples from the region, especially samples representing Woodland populations, are necessary for a more complete evaluation of microevolutionary changes in this lineage. Particularly critical to this endeavor are studies of Late Woodland populations. Many of the significant changes in morphological variation of the deciduous teeth of this lineage are associated with changes in subsistence practices that occurred at about 1000 BP. However, both the archaeological and biological record of this lineage is at best sketchy just prior to this time. Additional Late Woodland sites and samples are necessary in order to evaluate the specific causes of the biological and cultural changes made manifest at this time.

Even with the modest overall changes in frequency of some of the morphological variants in Ohio Valley populations, the general pattern of expression of morphological features of the deciduous dentition corresponds to what has been called the “Mongoloid Dental Complex” (Hanihara, 1967). This suite of features includes high frequencies of ui1 and ui2 shovel and lm2 deflecting wrinkle and moderate frequencies of lm2 protostylid, C7, and um2 C5. In a cladistic analysis of morphological features of the permanent dentition among human populations, Stringer et al. (1997) suggest that many features of the Sinodont Pattern (Turner, 1987), including I1 shovel and M1 deflecting wrinkle, are highly derived. If this is true for the permanent dentition, then it appears that these features as well as others may show the same character state polarity in the deciduous dentition. Delta form lm1 may be another highly derived feature of the Mongoloid Dental Complex of the deciduous dentition. Among European and related populations, this variant achieves a frequency of only 2–3% (Dahlberg, 1949; Jorgensen, 1956), and it was not found in a South African black population (Grine, 1986). However, delta form lm1 reaches moderate frequencies (22–57%) in some East Asian and derived populations (Hanihara, 1956; Dahlberg, 1949), including the Ohio Valley populations. The presence of an accessory distolingual root on lm1 and lm2 and double teeth may also be derived features, as they appear to be rare at least in European populations (>1%) while reaching appreciable frequencies in the Ohio Valley populations and some East Asian populations.

Finally, variants of root morphology, which are not generally considered in discussions of the deciduous dentition, appear to be quite common in human populations. Root grooves of the anterior teeth and the root sheath of um1 and um2 achieve moderate frequencies in both European and Ohio Valley populations (Jorgensen, 1956; Black, 1902). This distribution suggests these features may be primitive characteristics and thus common in most human populations.

LITERATURE CITED

Black GV (1902) Descriptive Anatomy of the Human Teeth. Philadelphia: SS White Dental Manufacturing Co.

Brace CL, Smith SL, and Hunt KD (1991) What big teeth you had grandma! Human tooth size past and present. In MA Kelley and CS Larsen (eds.): Advances in Dental Anthropology. New York: Wiley-Liss, pp. 33–58.

Brook AH, and Winter SB (1970) Double teeth: A retrospective study of “geminated” and “fused” teeth in children. Br. Dent. J. *129:*123–130.

Dahlberg AA (1949) The dentition of the American Indian. In WS Laughlin (ed.): Papers on the Physical Anthropology of the American Indian. New York: Viking Fund, pp. 138–176.

Dahlberg AA (1963) Analysis of the American Indian dentition. In DR Brothwell (ed.): Dental Anthropology. London: Pergamon Press, pp. 149–177.

Dancey WS (1988) The community plan of an early Late Woodland village in the middle Scioto river valley. Midcont. J. Arch. *13:*233–258.

de Souza P, and Houghton P (1977) The mean measure of divergence and the use of non-metric data in the estimation of biological distances. J. Arch. Sci. *4:*163–196.

Fritz GJ (1990) Multiple pathways to farming in precontact eastern North America. J. World Prehistory *4:*387–435.

Greenacre MJ (1984) Theory and Applications of Correspondence Analysis. New York: Academic Press.

Griffin JB (1983) The Midlands. In JD Jennings (ed.): Ancient North Americans. San Francisco: WH Freeman, pp. 243–301.

Grine FE (1986) Anthropological aspects of the deciduous teeth of South African blacks. In R Singer and JK Lundy (eds.): Variation, Culture and Evolution in African Populations. Johannesburg: Witwatersrand University Press, pp. 47–83.

Hanihara K (1956) Studies on the deciduous dentition of the Japanese and the Japanese-American hybrids. III Deciduous lower molars. J. Anthropol. Soc. Nippon *64:*95.

Hanihara K (1963) Crown characters of the deciduous dentition of the Japanese-American hybrids. In DR Brothwell (ed.): Dental Anthropology. London: Pergamon Press, pp. 104–124.

Hanihara K (1967) Racial characteristics in the dentition. J. Dent. Res. *46:*923–926.

Irish JD, and Morris DH (1996) Canine mesial ridge (Bushman Canine) dental trait definition. Am. J. Phys. Anthropol. *99:*357–359.

Jorgensen K (1956) The deciduous dentition: A descriptive and comparative anatomical study. Acta Odontol. Scand. *14:*1–202.

Lukacs JR, and Walimbe SR (1984) Deciduous dental morphology and the biological affinities of a late Chalcolithic skeletal series from western India. Am. J. Phys. Anthropol. *65:*23–30.

Mardia KV, Kent JT, and Bibby JM (1979) Multivariate Analysis. New York: Academic Press.

Saito T (1959) A genetic study of the degenerative anomalies of deciduous teeth. Jpn. J. Hum. Gen. *4:*27–54.

Sciulli PW (1977) A descriptive and comparative study of the deciduous dentition of prehistoric Ohio Valley Amerindians. Am. J. Phys. Anthropol. *47:*71–80.

Sciulli PW (1990a) Deciduous dentition of a Late Archaic population of Ohio. Hum. Biol. *62:*221–245.

Sciulli PW (1990b) Cranial metric and discrete trait variation and biological differentiation in terminal Late Archaic populations of Ohio: The Duff site. Am. J. Phys. Anthorpol. *82:*19–29.

Sciulli PW (1997) Dental evolution in prehistoric Native Americans of the Ohio Valley area: I Wear and pathology. Int. J. Osteoarch. *7:*507–524.

Sciulli PW, and Mahaney MC (1990) Evidence of local biological continuity for an Ohio Hopewell complex population. Midcont. J. Arch. *12:*117–114.

Smith BD (1989) Origins of agriculture in Eastern North America. Science *246:*1566–1571.

Smith P (1976) Evolutionary changes in the deciduous dentition of Near Eastern populations. Bull. Group. Int. Rech. Sci. Stomatol. *19:*187–198.

Smith P (1978) Evolutionary changes in the deciduous dentition of Near East populations. J. Hum. Evol. *7:*401–408.

Sokal RR, and Rohlf FJ (1981) Biometry. San Francisco: WH Freeman.

Stevenson DR (1985) Prevalence rate of double teeth in deciduous dentition at Averbuck (40DV60). Tenn. Anthropol. *10:*134–155.

Stothers DM, and Abel TJ (1989) The position of the "Pearson Complex" in the late prehistory of Ohio. Arch Of E. North America *17:*109–141.

Stringer CB, Humphrey LT, and Compton T (1997) Cladistic analysis of dental traits in recent humans using a fossil outgroup. J. Hum. Evol. *32:*389–402.

Tatarek NE, and Sciulli PW (1997) Comparisons of population structure in Ohio's Late Archaic and Late Prehistoric period. Amer. J. Phys. Anthropol. *24(Suppl.):*225–226.

Turner CG II (1971) Three-rooted mandibular first permanent molars and the question of American Indian origins. Am. J. Phys. Anthropol. *34:*229–242.

Turner CG II (1987) Late Pleistocene and Holocene population history of East Asia based on dental variation. Am. J. Phys. Anthropol. *73:*305–322.

Turner CG II, Nichol CR, and Scott GR (1991) Scoring procedures for bey morphological traits of the permanent dentition: The Arizona State University dental anthropology system. In MA Kelley and CS Larsen (eds.): Advances in Dental Anthropology. New York: Wiley-Liss, pp. 13–32.

Wagner GE (1987) Uses of Plants by the Fort Ancient Indians. Ph.D. dissertation, Washington University, St. Louis. Ann Arbor: University Microfilms.

Webb WS, and Baby RS (1957) The Adena People No. 2. Columbus, OH: The Ohio Historical Society.